

The ROVCO₂ Surface Decontamination System

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Introduction

The US Department of Energy (DOE) is currently tasked with decontamination of over one million square feet of nuclear contaminated concrete surfaces. Oceaneering International, Inc. (Oceaneering) proposed to the DOE to develop a system to improve the productivity and efficiency of concrete surface decontamination. We were subsequently awarded a contract to develop a Remote Operated Vehicle with CO₂ Blasting (ROVCO₂) system that automates blasting functions and eliminates secondary blasting waste. The initial target application is the cleaning of nuclear contaminated concrete surfaces, however, a system which eliminates secondary blasting waste has multiple applications in the clean-up industry. Oceaneering has led its team in the design, production, integration, testing, and demonstration of the critical subsystems of the ROVCO₂ system.

Project Description

The 1,000 lb ROVCO₂ system integrates a remotely operated vehicle and an enhanced commercial CO₂ blasting system with an Oceaneering-developed work arm and control system. The remote operation of the system protects the operator from contamination and supports functional automation of tedious tasks.

The CO₂ blasting system shoots pellets of dry ice propelled by pressurized gas at a surface to be cleaned. The impact of the dry ice pellets fractures and scales off a layer of the contaminated surface. At impact, the pellets return to a gaseous state which is vacuumed up with the debris. The CO₂ gas and debris are passed through the vacuum filter system, leaving only the removed material for waste disposal.

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Accomplishments

Oceaneering proposed a simple, three phase program which consisted of developing a concept design and then constructing the apparatus, testing the system and all its subsystems in a controlled environment, and finally field testing the ROVCO₂.

Oceaneering's Phase 1 approach to the ROVCO₂ design and build was based upon proven design and build procedures which are in the process of being certified as ISO 9001 compliant. In Phase 1, critical subsystems including: CO₂ blasting, the vehicle, manipulation, and controls were developed, integrated, and tested.

The purpose of Phase 2 was to perform detailed testing on ROVCO₂ under normal operating conditions. The trial was conducted on-site at Oceaneering from August to October, 1995. This trial successfully demonstrated the capabilities of the ROVCO₂ system. At the end of Phase 2 of the ROVCO₂ Program, nearly 100% of the success criteria were achieved. The ROVCO₂ system was shown in testing to effectively and productively remove coatings and contaminants from concrete floors achieving:

- Removal rates of 98 % for smearable and 75% for the fixed contamination,
- Productivity rates averaging 52.5 square feet per hour on epoxy paint and concrete sealant,
- Tested availability of over 85%, and
- Estimated operational cost of \$0.72 per square foot including waste disposal

In Phase 2, the off-the-shelf subsystems consisting of Vacuum/Filter/Containment System (VFCS) and the Tether Management System (TMS) were integrated onto the ROVCO₂ system. The winch, slip ring, and vacuum/filter system were all procured from commercial vendors. Oceaneering's innovations kept the program within budget by inexpensively making the TMS umbilical in-house when vendors' bids were beyond the budget. When Oceaneering discovered in testing that the vendor's containment workhead would not perform as advertised, we responded to keep the program on track. To correct the workhead containment, Oceaneering revised the test schedule, designed a workhead based on a different principle, fabricated a prototype, tested the prototype, analyzed the test results, and developed a final containment workhead design that we

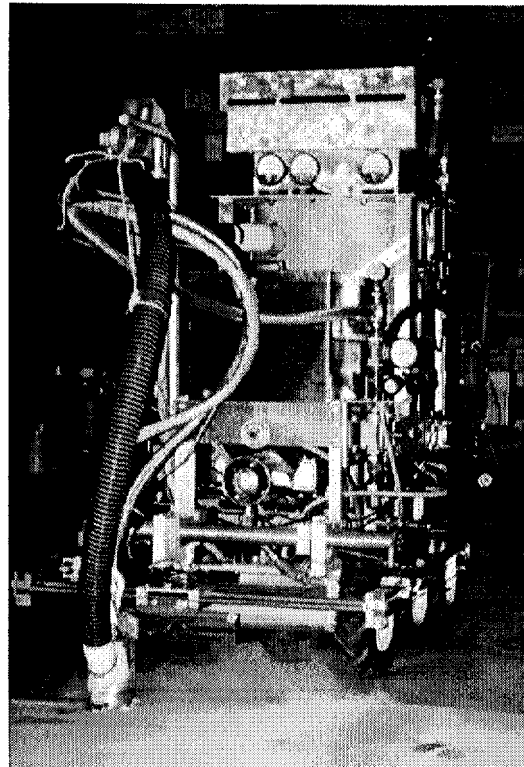


Figure 1: *The successful productivity testing of the ROVCO₂ vehicle proved its effectiveness and cost efficiency in Phase 2.*

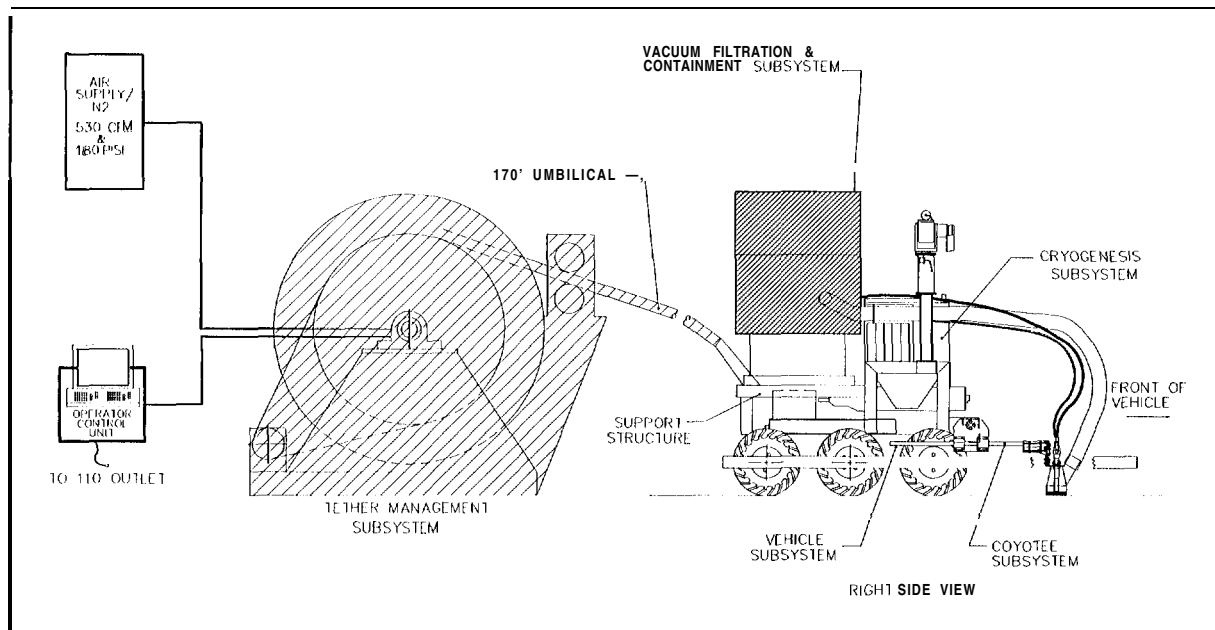


Figure 2: Oceaneering's project team integrated the off-the-shelf subsystems into the ROVCO₂ system during Phase 2.

propose for the next phase, all within budget. The only success criterion we didn't achieve was a direct result of the non-performance of the commercial workhead, however, with our newly designed workhead, we can easily meet this criterion.

The testing in Phase 2 quantified all ROVCO₂ performance parameters including:

- Decontamination effectiveness with laboratory tests measuring surrogate contaminants at realistic levels,
- Productivity with large area coating removal tests on both epoxy paint and concrete floor sealant, and
- Reliability and availability with analysis and long duration operation of the system.

The testing has documented the success of the ROVCO₂ development.

Future Activities

In the third and final phase of the ROVCO₂ program, we will transition ROVCO₂ from development to work, completing our contractual obligations to the Department of Energy. During this phase, we will complete final integration and testing of a newly developed containment workhead and the hot test as part of a site decontamination. In addition to these

technical tasks, administrative and reporting tasks will assure full compliance with environmental requirements and health physics requirements.

The fully tested and operational ROVCO₂ system with all its subsystems and their components, necessary operations personnel, and key personnel will travel to the designated facility for the deployment. At the facility, all our personnel will attend RCA training as required by the facility.

Although the original solicitation suggested that the hot test would be conducted at ORNL'S K-25 site, several other sites have expressed interest as possible facilities for the decontamination or subsequent work. Among these are:

- Hanford Plutonium Finishing Plant (PFP), Canyon decontamination,
- Argonne National Laboratory CP5 Reactor Large Scale Demonstration, or
- ICF Kaiser Hanford Building 375 Hot Cell decontamination, and
- WHC sitewide waste minimization program.

The ROVCO₂ hot test will include equipment setup, decontamination of the designated test area, and equipment decontamination (for service and storage). Disposition of all government equipment from the contract will be as directed by DOE. The hot test will provide a practical check if the ROVCO₂ system and a numerical determination of its decontamination effectiveness. A third party will take possession of the hazardous material and be responsible for its disposal.

We propose two additional tasks: one has evolved from the testing during phases 1 and 2; and one is in response to a request from Joseph Boudreaux, D&D Program Manager at Florida International University (FIU). These tasks will be added at DOE's option. The remote operated vehicle development contract will benefit from these additional tasks in two ways: the redesigned workhead will improve containment and maneuverability, and the FIU test will document the significance of our joint efforts in developing this technology.

Acknowledgments

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